Unmanned aerial system Traffic Management System & Beyond

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How can small UASs access the airspace?

Sample applications:

e.g. PUBLIC SAFETY, INSPECTION, PRECISION AGRICULTRUE

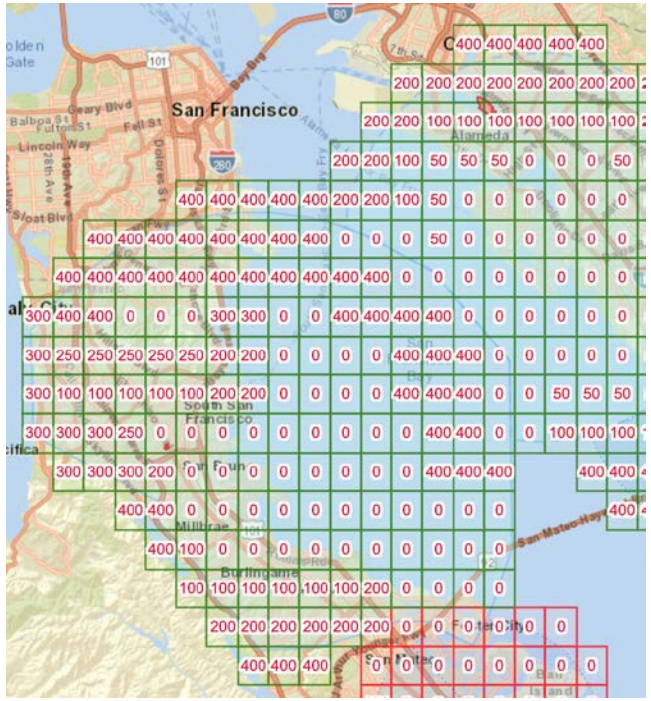

e.g. SMALL PACKAGE (e.g. medical) DELIVERY


e.g. UAS MULTI-PACKAGE (e.g. food, commercial goods) DELIVERY

and more…

Access the airspace

- August 2016: Title 14 Code of Federal Regulations (CFR) part 107
- October 2017: Low Altitude Authorization Notification Capability (LAANC)



- Near real-time processing
- Covers controlled airspace near airports
- Grid-based
- Limitations: coverage, flexibility, efficiency, and scalability

A more efficient and scalable airspace system is still needed.

UTM System

In 2014, NASA started the UTM project to address **existing critical gaps exist to enable multiple BVLOS operations in low-altitude airspace**

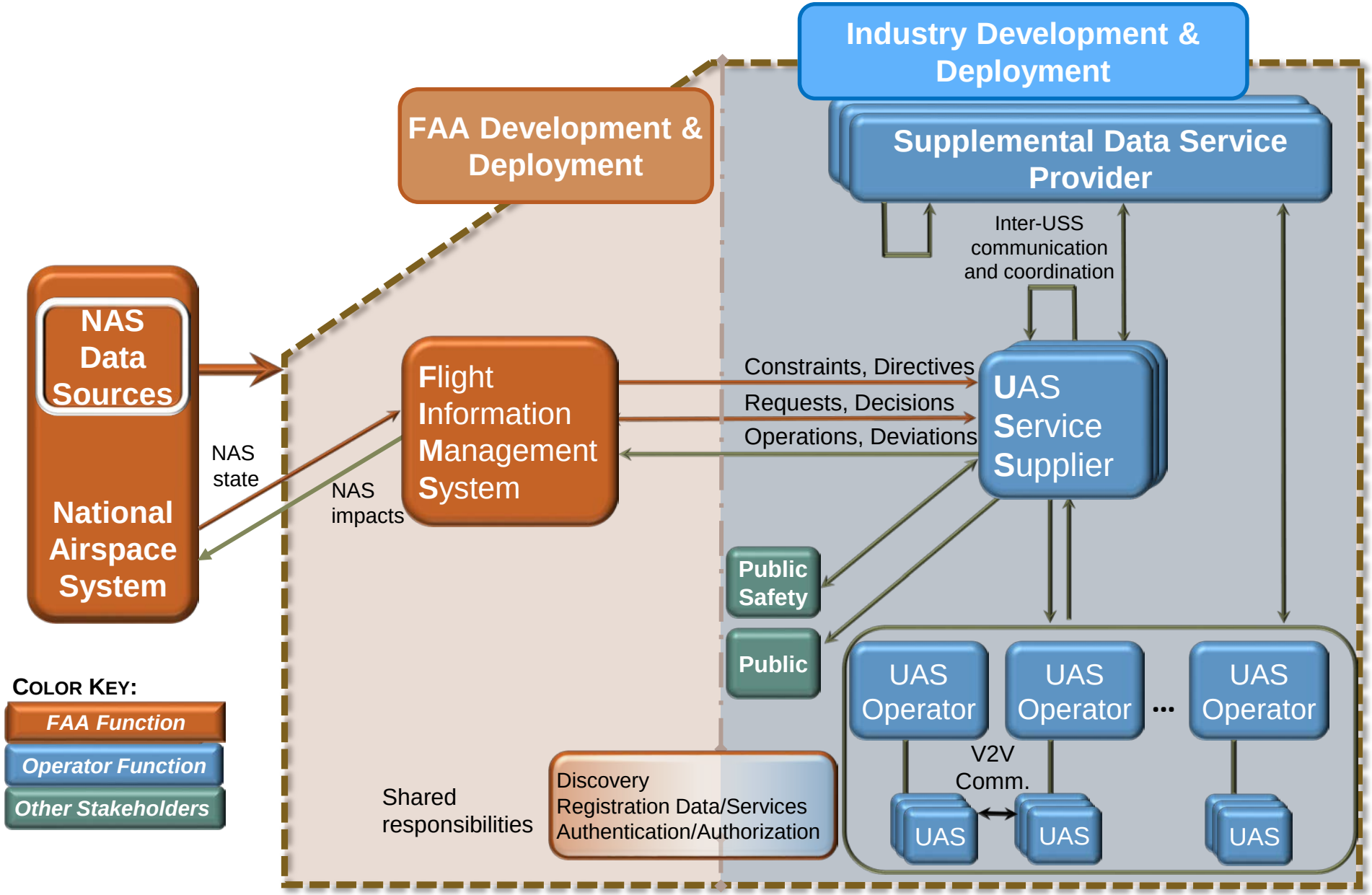
- UTM is an “air traffic management” ecosystem for uncontrolled operations
- Utilizes industry’s ability to supply services under FAA’s regulatory authority where these services do not exist
- Development will enable the management of large scale, low-altitude UAS operations
  - Address beyond visual line of sight UAS operations under 400 ft. AGL
  - Define roles/responsibilities of FAA, operators, and other stakeholders
  - Define information architecture, data exchange protocols, software functions
  - Recommend performance requirements

Operational Assumptions

Key principle: safely integrating UAS operations without burdening current ATM

- FAA maintains regulatory *AND* operational authority for airspace and traffic operations
- Air traffic controllers **are not required** to actively "control" every UAS in uncontrolled airspace or uncontrolled operations inside controlled airspace
- FAA has on-demand access to airspace users and can maintain situation awareness and issue directives, constraints, and airspace configurations through UTM for safety reasons anytime

UTM Service-Based Architecture

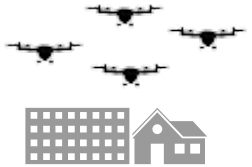


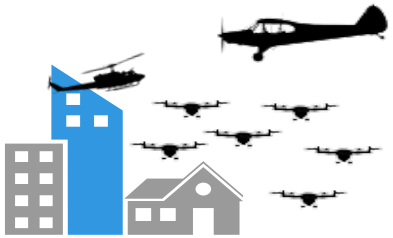
Partnerships and Collaboration Approach

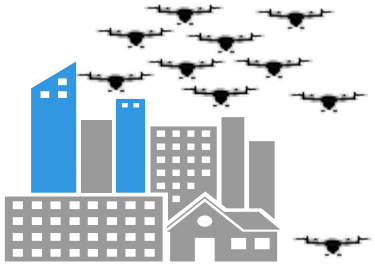
- FAA and NASA are actively and closely collaborating
- Over 200 collaborators: Government, industry, academia and FAA test sites
  - Joint UTM Project Plan (JMP) Dec. 2016 (completed)
  - Four Research Transition Teams (formed in Jan. 2017)
    - Concepts & Use Cases
    - Data Exchange & information Architecture
    - Communications & Navigation
    - Sense & Avoid
  - UTM Pilot Program (April 2017 to 2019)
  - Nine industry USS developers established in 2019

Technical Capability Levels (TCL)

Risk-based development and test approach along four distinct TCLs



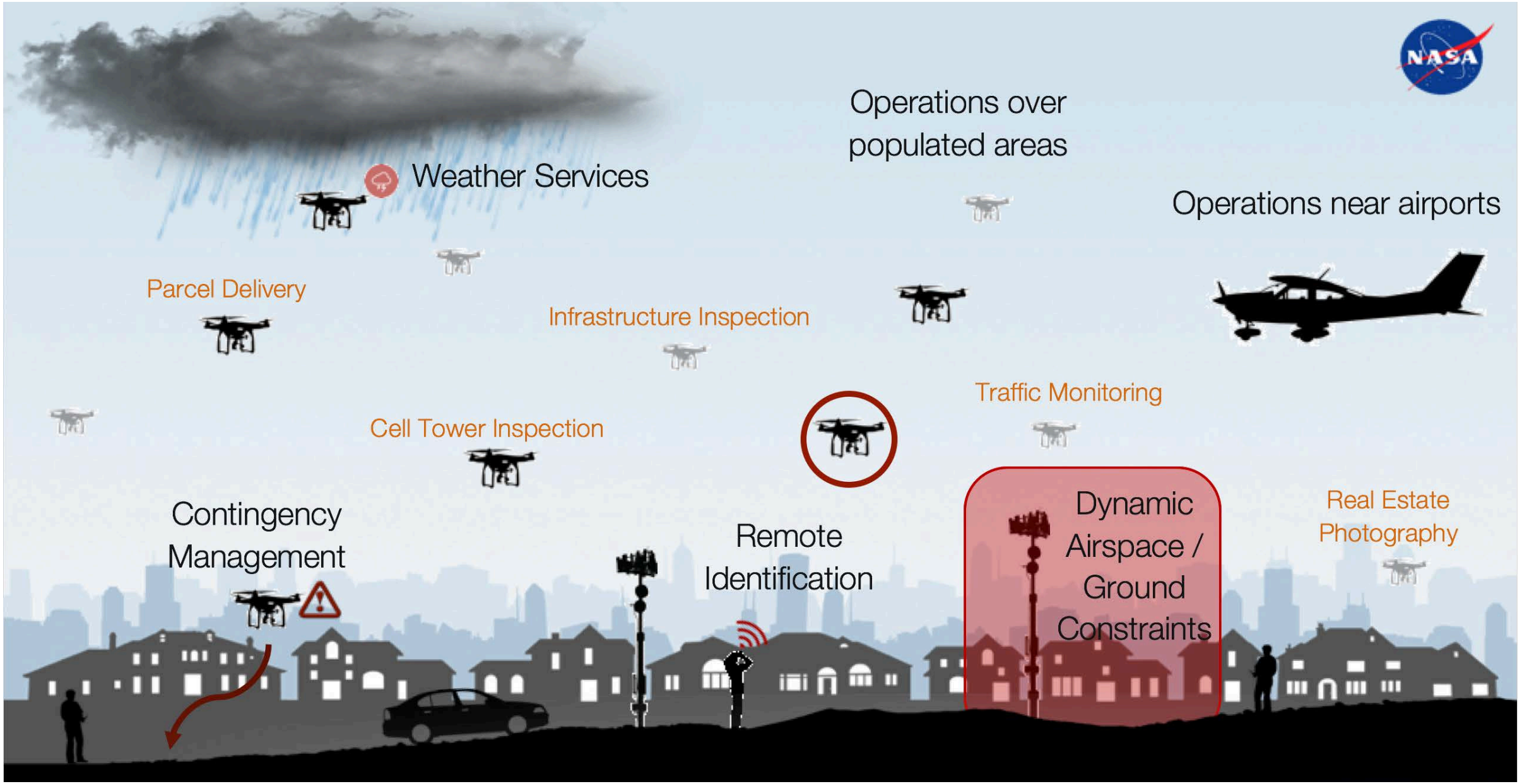




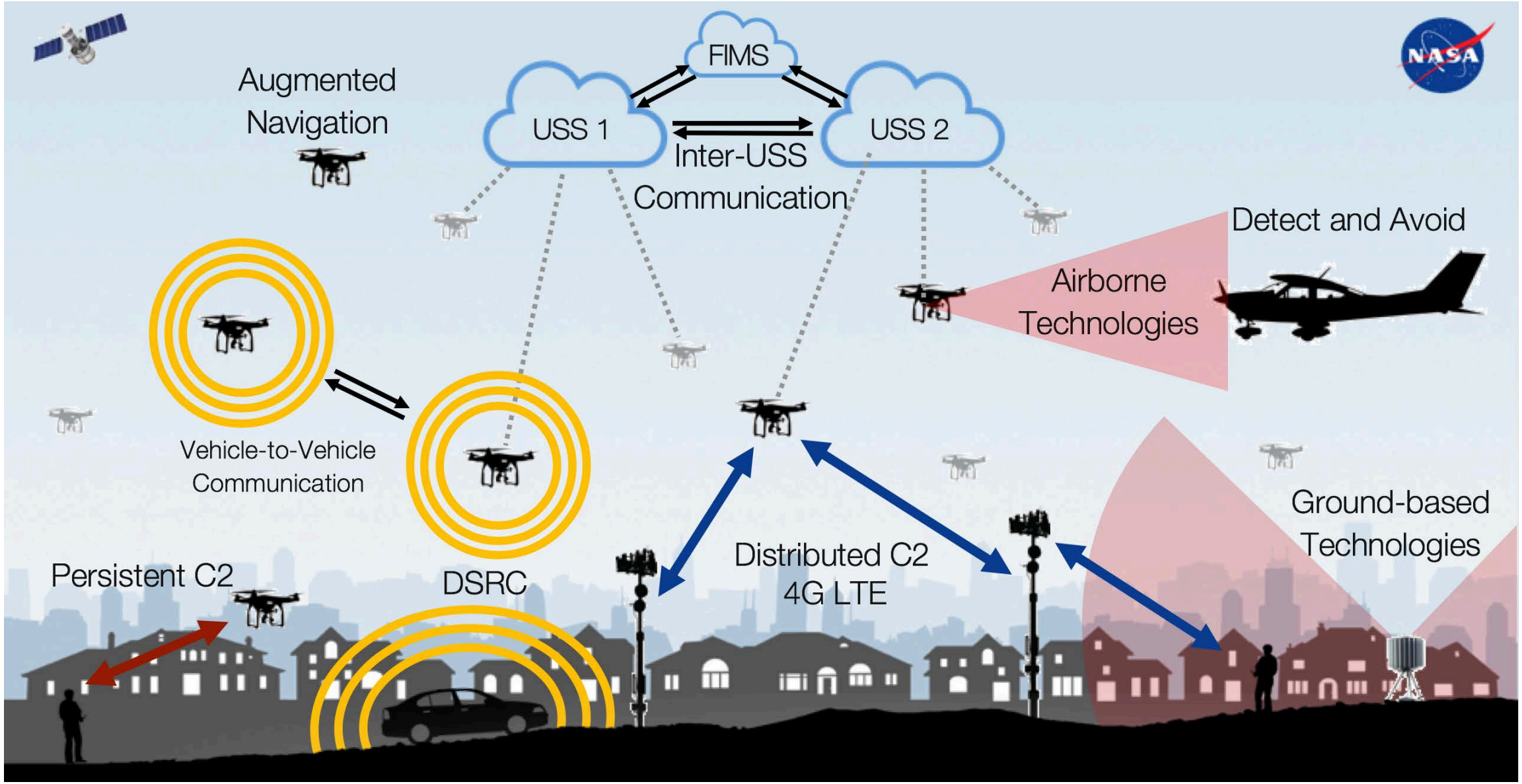
TCL4: Summer 2019

	TCL 1	TCL 2	TCL 3
What	Concept for management of airspace in lower risk environments and multiple visual line-of-sight (VLOS) UAS operations	Complex multiple beyond visual line of sight (BVLOS) UAS Operations in lower risk environments	Technologies needed for BVLOS UAS Operations over populated areas and near airports
When	Aug 2015, May 2016	October 2016, May 2017	March-June 2018
Outcomes	Validation of cloud-based service oriented architecture	Information sharing between operators, and established federated 3rd party service model	Technologies for detect and avoid, comm. and nav., and data exchange between multiple USS

TCL 3: services and functions



TCL 3: Communication, Navigation, and Surveillance



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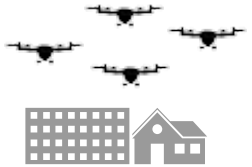
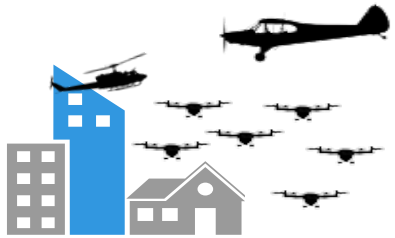
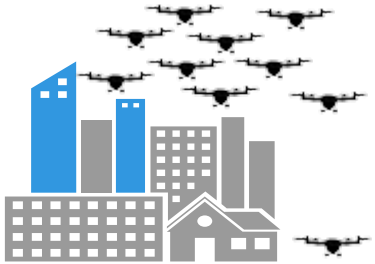
Risk-based development and test approach along four distinct TCLs





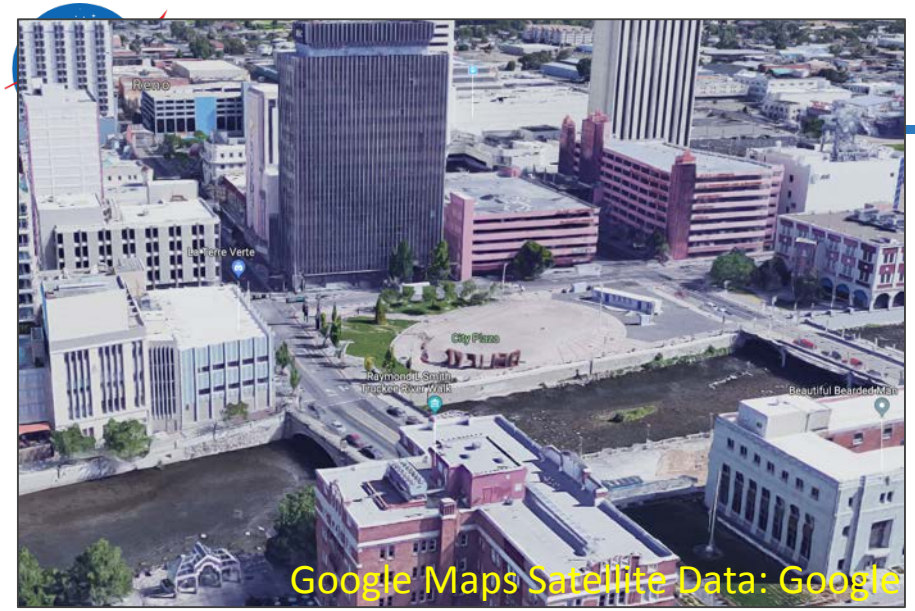


	TCL 1	TCL 2	TCL 3	TCL 4
What	Concept for management of airspace in lower risk environments and multiple visual line-of-sight (VLOS) UAS operations	Complex multiple beyond visual line of sight (BVLOS) UAS Operations in lower risk environments	Technologies needed for BVLOS UAS Operations over populated areas and near airports	Complex BVLOS operations in urban environment, nominal and contingency situations
When	Aug 2015, May 2016	October 2016, May 2017	March-June 2018	Summer 2019
Outcomes	Validation of cloud-based service oriented architecture	Information sharing between operators, and established federated 3rd party service model	Technologies for detect and avoid, comm. and nav., and data exchange between multiple USS	(Expected) Operational concept, vehicle technologies, and data exchanges for operations near large structures and in highly populated areas

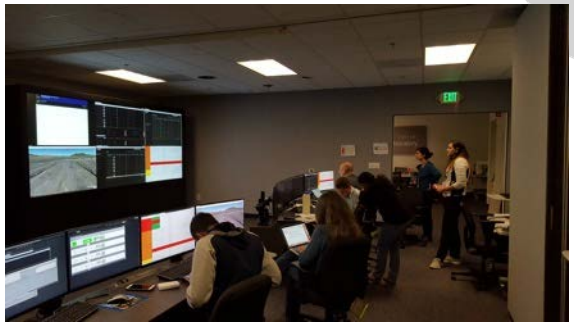
TCL 4: Complex Urban Environments

Key Technical Areas to Investigate

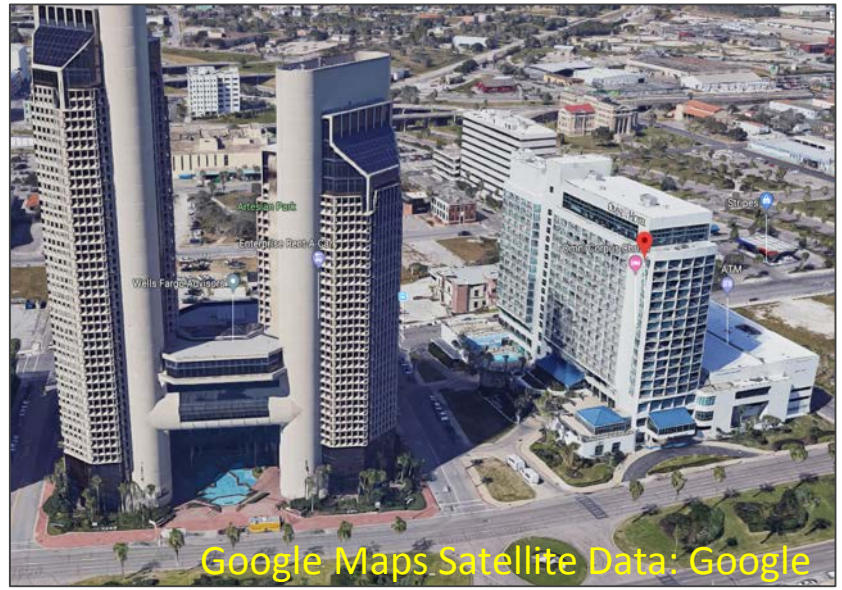
- **Communication/ Navigation** degradation and denial
- **Vehicle separation** in nominal and off-nominal conditions
- **Remote identification** of UAS
- **Obstacle Avoidance** (dynamic and static)
- **High density / high tempo operations**
- **USS-USS** discovery and negotiations
- **Supplemental data services** supporting operations (e.g. weather, health monitoring, risk monitoring)
- **Safe Landing**



Reno test range



ARC UTM Command Center



Corpus Christi test range

TCL 4 awards made to Nevada and Texas FAA-designated UAS test sites

Flight Test Highlights

5
Scenarios

24
Test Objectives

18
Unique UAS Types

Participating Organizations
36

17
Unique Tests

7
USS developers

2 FAA UAS Test Sites
Nevada
Texas

2 test locations
Reno, Nevada
Corpus-Christi, Texas

Flight Window
May – August

Nevada
Shakedown: May
Demo: June

Texas
Shakedown: July
Demo: August

Required Test Scenarios

- 5 Scenarios have been created that are designed to represent a “day in the life of UAS operations” in a geographic region
- Each scenario has multiple required missions (i.e. package delivery), defining characteristics (i.e. high density), and a set of triggering events (i.e. collision avoidance encounter) that exercise different technologies and procedures

  *1: Normal **High Density** Operations interrupted by a **Weather Event***

  *2: **Pop up** Concert in a Park, **Emergency** Operations, **Temporary** Airspace Restriction*

  *3: **UAS Near Airport**, **Mixed Operation** with Manned AC, Rogue UAS*

  *4: Flight **Over People**, **Safe Landing**, UAS **Obstacle** Collision and Reaction*

  *5: **High Density** Operations, **USS Negotiation**, USS Failure*

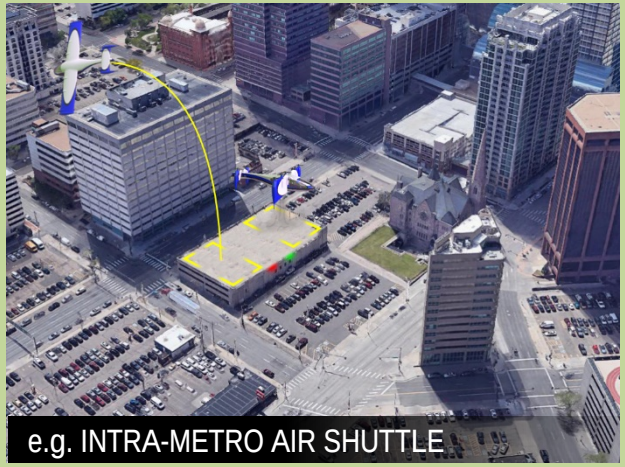
What’s next?

Urban Air Mobility

Non-Passenger Carrying Reference Missions

INITIAL STATE **INTERMEDIATE STATE** **MATURE STATE**

Passenger Carrying Reference Missions



UTM systems for The UAM “Grand Challenge”

Extensions of the UTM system:

- Integration with UAM vehicles
- Interoperability with current ATM
- Operations above 400 feet
- High density, high tempo trajectory-based operations (TBO)
- and more…

Potential Gaps

- To vehicle developers: Integration and interaction with the UTM airspace system is critical.
- To everyone: Great opportunities to participate the UTM airspace system development.
  - Infrastructures: communication, navigation, and surveillance infrastructure
  - Services: weather, conflict management, vertiport management, etc.
  - Airspace system: concept, roles and responsibilities, policies, requirements, standards, etc.

Summary

- NASA developed a UTM ecosystem, together with FAA and industries.
- UTM TCL 4 begins testing in June 2019 with two national test sites, to be completed by August 2019.

- NASA is planning Grand Challenges for UAM operations, based on the UTM construct.
- Vehicle and airspace systems need to be integrated.
- Many opportunities exist to participate the airspace system development for both UTM and UAM.

Questions

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